N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE

80-10308
NASA CR-160698

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
P.O. Box 8618
Ann Arbor, Michigan 48107

Progress Report

for

NASA Contract NAS9-15476

ANALYSIS OF SCANNER DATA FOR CROP INVENTORIES

(E80-10308) ANALYSIS OF SCANNER DATA FOR CROP INVENTORIES Progress Report, 15 Nov. 1979 - 15 Feb. 1980 (Environmental Research Inst. of Michigan) 97 p HC A05/MF A01 CSCL 05B G3/43
N80-30874
Unclas
00308

Program Manager

Robert Horvath

Program Area Managers

Richard C. Cicone
Richard J. Kauth
William A. Malila

Period Covered

15 November 1979 - 15 February 1980

ERIM Report Number 132400-39-P

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
132400-39-P		

4. Title and Subtitle	5. Report Date
Progress Report for 15 November 1979 - 15 February 1980	May 1980
	6. Performing Organization Code
7. Author(s) R. Horvath, R. Cicone, R. Kauth, W. Malila	8. Performing Organization Report No. 132400-39-P
9. Performing Organization Name and Address Environmental Research Institute of Michigan P.O. Box 8618 Ann Arbor, Michigan 48107	10. Work Unit No.
	11. Contract or Grant No. NAS9-15476
12. Sponsoring Agency Name and Address National Aeronautics & Space Administration Johnson Space Center Houston, Texas 77058 Mr. I. Dale Browne/SF3	13. Type of Report and Period Covered Progress Report 15 November 1979 - 15 February 1980
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report summarizes the progress on subject contract during the first quarter of the 1980 contract year. It is comprised of the presentations supporting quarterly project management reviews and a quarterly technical interchange meeting.

17. Key Words	18. Distribution Statement
Crop Inventory, Landsat, Sampling, Crop Modeling, Analyst Labeling, Area Estimation, Multiyear Estimation	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

PREFACE

The following report serves as the Quarterly Report for Contract NAS9-15476 which is entitled "Analysis of Scanner Data for Crop Inventories". This report describes the work carried out under that contract for the period 15 November 1979 through 15 February 1980.

Work on this contract is performed in the Infrared and Optics Division directed by Mr. Richard R. Legault. Mr. Robert Horvath is the Program Manager for this contract.

This contract, performed by the Environmental Research Institute of Michigan (ERIM) for the Earth Observations Division of the NASA/ Johnson Space Center, is part of the multi-agency AgRISTARS Program and supports both the Supporting Research (SR) and Foreign Commodity Production Forecasting (FCPF) Projects within AgRISTARS. The overall goal of AgRISTARS is to determine the usefulness, cost and extent to which aerospace remote sensing data can be integrated into existing or future U.S. Department of Agriculture (USDA) systems to improve the objectivity, reliability, timeliness and adequacy of information required to carry out USDA missions.

PRECEDING PAGE BLANK NOT FILMED

TABLE OF CONTENTS

PRECEDING PAGE BLANK NOT FILMED

CORN AND SOYBEAN CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION FOR SUPPORTING RESEARCH

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
UNIVERSITY OF CALIFORNIA AT BERKELEY

14 FEBRUARY 1980 SR SEMIANNUAL PROJECT REVIEW

OBJECTIVES

- RESEARCH AND DEVELOP C/S AREA ESTIMATION TECHNOLOGIES ADAPTABLE BY FCPF FOR EVALUATION IN FOREIGN EXPLORATORY EXPERIMENTS.

- CONDUCT U.S. EXPLORATORY EXPERIMENTS IN ADVANCED AREA ESTIMATION TECHNOLOGY FOR CORN AND SOYBEANS IN SUPPORT OF PILOT EXPERIMENTS.

- DELIVER PILOT-COMPATIBLE ADVANCED AREA ESTIMATION PROCEDURES IN THE PROCESS OF CONDUCTING U.S. EXPLORATORY EXPERIMENTS.

SCOPE OF SR RELATED PROGRAM

- IDENTIFY REQUIREMENTS FOR CORN AND SOYBEAN AREA ESTIMATION TECHNOLOGY BASED ON CURRENT TECHNOLOGY.
- RESEARCH AND DEVELOP COMPONENTS FOR AN END-TO-END SEGMENT-BASED AREA ESTIMATION TECHNOLOGY.
- DELIVER COMPONENTS TO FCPF FOR FOREIGN ADAPTATION, TEST AND EVALUATION.
- RESEARCH, DEVELOP, TEST AND EVALUATE ADVANCED AREA ESTIMATION TECHNOLOGIES FOR CORN AND SOYBEAN THAT ARE NOT NECESSARILY SEGMENT BASED.
- RESEARCH, DEVELOP, TEST AND EVALUATE METHODOLOGIES USING THEMATIC MAPPER FOR CORN AND SOYBEAN AREA ESTIMATION.
- IMPLEMENT PILOT-COMPATIBLE PROCEDURES FOR ADVANCED TECHNOLOGIES.

C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

TECHNOLOGY PHASES

EVENT	U.S. Pilot FY 81	Brazil Expl. Exp. FY 82	Argentina Expl. Exp. FY 83	U.S. P2 Expl. Exp. FY 83	U.S. TM Expl. Exp. FY 84	Brazil/Argentina P2 Expl. Exp. FY 85
TECHNICAL THRUST	End of Season	Throughout Season Foreign Understanding	Objective Labeling Throughout Season Small Fields Foreign Understanding	Multisegment Full-Frame	Advanced Labeling Small Fields	Self Assessment Foreign Understanding
FUNDAMENTAL EMPHASIS	Baseline	Accuracy Timeliness	Accuracy Timeliness	Efficiency	Accuracy	Objectivity Efficiency

C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

SUPPORTING RESEARCH TASKS

	FISCAL YEAR	PERFORMING INSTITUTE
1. CURRENT AREA ESTIMATION TECHNOLOGY DEVELOPMENT		
1.1 Improve at harvest area estimation technology	80-81	ERIM
1.2 Midseason labeling and area estimation	80-81	UCB/ERIM
1.3 Early season labeling and area estimation	80-81	UCB/ERIM
1.4 Multiyear (preseason) area estimation	81-82	ERIM
1.5 Error model development	81	ERIM
1.6 Corn and soybean feature definition	80-81	UCB
1.7 Contextual information extraction	81	UCB
2. ADVANCED AREA ESTIMATION TECHNOLOGY DEVELOPMENT		
2.1 Advanced design	80-82	ERIM/UCB
2.2 Advanced technology development	81-83	ERIM/UCB
2.3 Implementation	81-83	ERIM
2.4 Exploratory testing	82-84	ERIM
3. AREA ESTIMATION TECHNOLOGY DEVELOPMENT WITH THEMATIC MAPPER	82-84	ERIM/UCB

ACTIVITIES AND ACCOMPLISHMENTS
(15 Nov 79 - 13 Feb 80)

- Implementation Approach Approved by NASA Level 2 Management
- Implementation Plan
  - Tasks defined (PCRs initiated)
  - Overall schedule defined

FUTURE PLANS

14 FEB 80 - 13 AUG 80

- COMPLETE IMPLEMENTATION PLAN (MARCH 80)
- INITIATE DEVELOPMENT OF ADVANCED END OF SEASON MACHINE PROCESSING PROCEDURES (MAY 80)
- INITIATE DEVELOPMENT OF MIDSEASON CORN AND SOYBEAN LABELING PROCEDURES (JUNE 80)
- FORM P2 DESIGN GROUP (APRIL 80)
  - INITIATE SURVEY OF 'P2' LIKE TECHNOLOGIES
  - INITIATE DEVELOPMENT OF ALTERNATIVE 'P2' DESIGNS

PLANNED ACHIEVEMENTS
(1980 - 1985)

1980	Implementation of Baseline Area Estimation Technology for End of Season Estimates in U.S. Indicator Region.
1981 - 1982	Through the Season Estimates, Improved End of Season Technology for Brazil.
1982 - 1983	Small Fields Methodology, Objective Labeling Technology for Argentina.
1983 - 1984	P2, Multisegment and/or Full-Frame Sampling Thematic Mapper, Multistage Techniques.
1985	System Self-Assessment, Advanced Procedures in Foreign Environment.

ISSUES

- AVAILABILITY OF FOREIGN AGRONOMIC DATA (SEGMENTS) AND CHARACTERIZATION

CORN AND SOYBEAN CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

FOR

FOREIGN COMMODITY PRODUCTION FORECASTING

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
UNIVERSITY OF CALIFORNIA AT BERKELEY
NASA, JOHNSON SPACE CENTER, SF4

13 FEBRUARY 1980 FCPF SEMIANNUAL PROJECT REVIEW

PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DTIC
PAGE WAS NOT FILMED

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

OBJECTIVES

- Conduct Foreign Exploratory Experiments in Area Estimation Technology for Corn and Soybeans in Support of Pilot Experiments.
- Deliver Pilot-Compatible C/S Area Estimation Procedures.
- Support Pilot

SCOPE OF FCPF RELATED PROGRAM

- IDENTIFY COMPONENT TECHNOLOGIES FOR CORN AND SOYBEAN AREA ESTIMATION.
- ADAPT TECHNOLOGY TO FOREIGN APPLICATION.
- DEVELOP END-TO-END PROCEDURES FOR EXPLORATORY EXPERIMENT TESTING.
- IMPLEMENT PILOT-COMPATIBLE PROCEDURES FOR TEST AND EVALUATION.
- COMPARATIVELY TEST AND EVALUATE TECHNOLOGIES.
- SUPPORT SUBSEQUENT MODIFICATION AND PILOT TESTING.

C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT
TECHNOLOGY PHASES

EVENT	U.S. Pilot FY 81	Brazil Expl. Exp. FY 82	Argentina Expl. Exp. FY 83	U.S. P2 Expl. Exp. FY 83	U.S. TM Expl. Exp. FY 84	Brazil/Argentina P2 Expl. Exp. FY'85
TECHNICAL THRUST	End of Season	Throughout Season Foreign Understanding	Objective Labeling Throughout Season Small Fields Foreign Understanding	Multisegment Full-Frame	Advanced Labeling Small Fields	Self Assessment Foreign Understanding
FUNDAMENTAL EMPHASIS	Baseline	Accuracy Timeliness	Accuracy Timeliness	Efficiency	Accuracy	Objectivity Efficiency

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION*

PROJECT ELEMENT TASKS

	TASK	FISCAL YEAR	PERFORMING INSTITUTE
1.	US C/S AREA ESTIMATION PROCEDURE DESIGN	80	ERIM/UCB
2.	US C/S LABELING LOGIC DEVELOPMENT	80	UCB
3.	US C/S PROCEDURES IMPLEMENTATION	80/81	ERIM/UCB
4.	US C/S EXPLORATORY TEST AND EVALUATION	80	JSC/SF4
5.	US C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	81	JSC/SF4
6.	BRAZIL C/S AREA ESTIMATION PROCEDURE DESIGN	81	ERIM/UCB
7.	BRAZIL C/S LABELING LOGIC DEVELOPMENT	81	UCB
8.	BRAZIL C/S PROCEDURES IMPLEMENTATION	81	ERIM/UCB
9.	BRAZIL EXPLORATORY TEST AND EVALUATION	81	ERIM
10.	BRAZIL C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	82	JSC
11.	ARGENTINA C/S AREA ESTIMATION PROCEDURE DESIGN	81/82	ERIM/UCB
12.	ARGENTINA C/S LABELING LOGIC DEVELOPMENT	82	UCB/ERIM
13.	ARGENTINA C/S PROCEDURES IMPLEMENTATION	82	ERIM
14.	ARGENTINA C/S EXPLORATORY TEST AND EVALUATION	82	ERIM
15.	ARGENTINA C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	83	JSC

*Management Responsibility at ERIM

ACTIVITIES AND ACCOMPLISHMENTS
(15 Nov 79 - 13 Feb 80)

- Implementation Approach Approved by NASA Level 2 Management
- Implementation Plan
  - Tasks defined
  - Interface requirements identified
  - Integrated schedule completed
- Baseline Procedure Design
  - Preliminary procedure and interface requirements identified
- Labeling Logic Development
  - UCB/LEC procedure integration underway
- Pilot Baseline Implementation
  - ERSYS 'CMS' design support
  - ERSYS data link requirements defined
- FY 80 C/S Exploratory Experiment
  - Objectives established
  - Design underway

FUTURE PLANS

14 FEB 80 - 13 AUG 80

- COMPLETE IMPLEMENTATION PLAN (MARCH 1980)
- COMPLETE DESIGN OF BASELINE AREA ESTIMATION PROCEDURE (APRIL 1980)
- COMPLETE BASELINE LABELING LOGIC DEFINITION (JULY 1980)
- BEGIN BASELINE PROCEDURE IMPLEMENTATION
- EXPLORATORY TEST AND EVALUATION
  - EXPERIMENT DESIGNED (APRIL 1980)
  - SEGMENT PROCESSING COMPLETE (JULY 1980)

PLANNED ACHIEVEMENTS
(1980 - 1985)

1980	Implementation of Baseline Area Estimation Technology for End of Season Estimates in U.S. Indicator Region.
1981 - 1982	Through the Season Estimates, Improved End of Season Technology for Brazil.
1982 - 1983	Small Fields Methodology, Objective Labeling Technology for Argentina.
1983 - 1984	P2, Multisegment and/or Full-Frame Sampling Thematic Mapper, Multistage Techniques.
1985	System Self-Assessment, Advanced Procedures in Foreign Environment.

ISSUES

- THIS PLAN BASED UPON DETAILED ASSUMPTIONS REGARDING ERSYS DELIVERY. IF ASSUMPTIONS PROVE WRONG, REPLANNING WILL BE NECESSARY. OPTIONS DO EXIST.

- NO IDENTIFIABLE SOURCE FOR CHARACTERIZATION OF FOREIGN AGRONOMY.

U.S. CORN/SOYBEANS PILOT EXPERIMENT
CLASSIFICATION FOR AREA ESTIMATION

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
AND
UNIVERSITY OF CALIFORNIA AT BERKELEY

13 FEBRUARY 1980 FCPF SEMIANNUAL PROJECT REVIEW

PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DTIC
ALL DTIC REPRODUCTIONS WILL BE IN BLACK AND WHITE
PAGE WAS NOT FILMED

FY80 OBJECTIVE

IMPLEMENT, DOCUMENT AND VALIDATE AT JSC

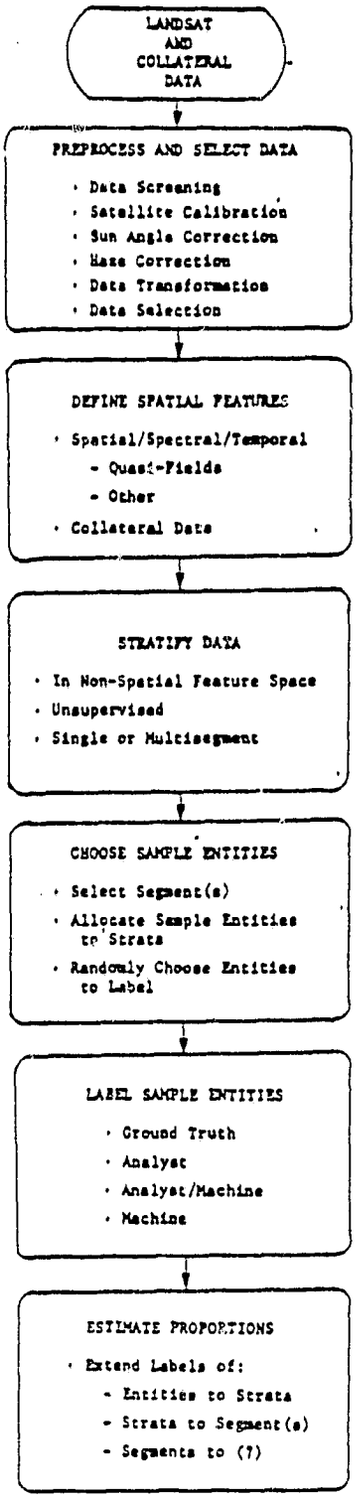
AN AREA ESTIMATION (CLASSIFICATION) PROCEDURE

FOR THE FY81 U.S. C/S PILOT

FY81 U.S. C/S PILOT IMPLEMENTATION APPROACH

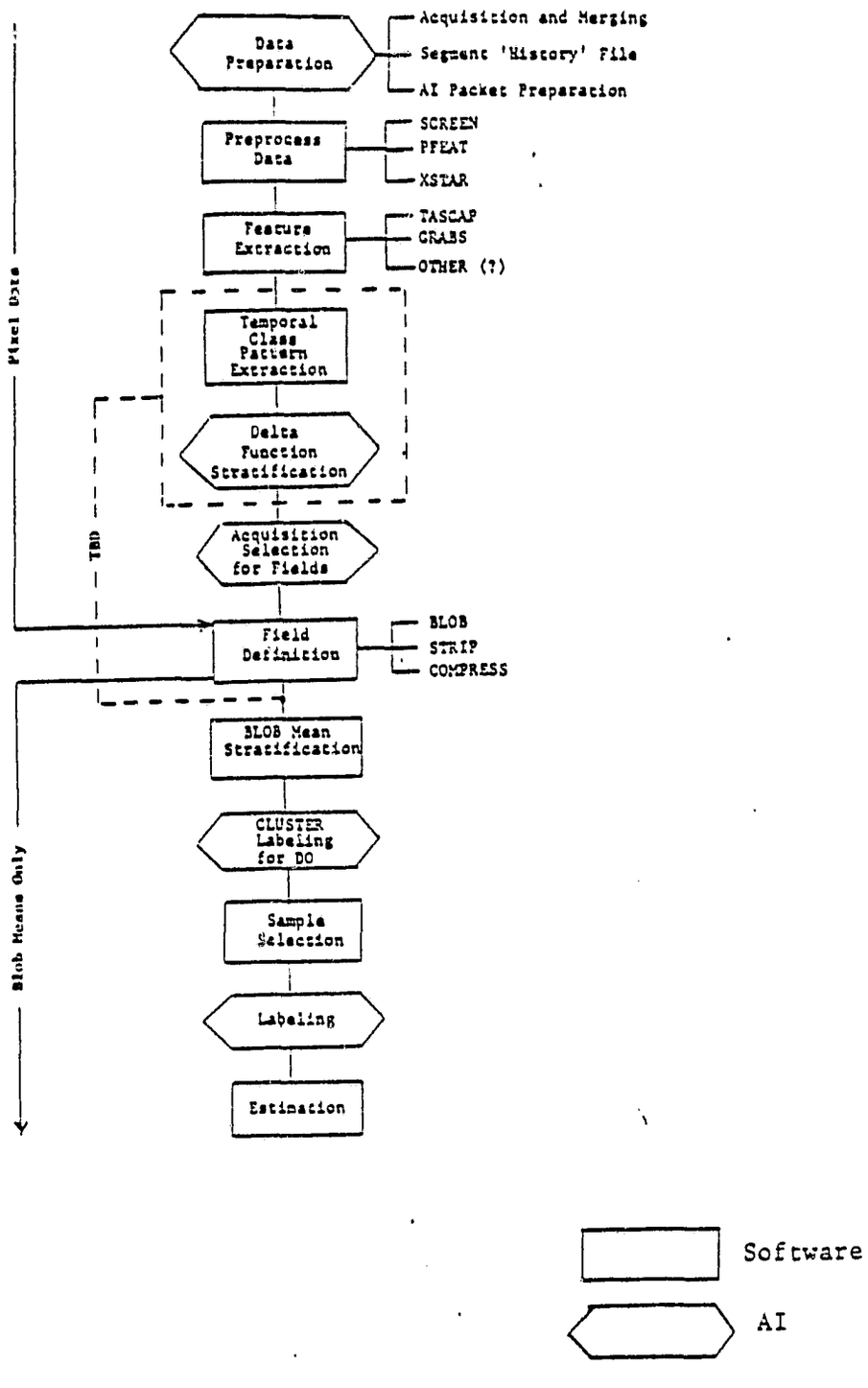
- Overall Implementation Managed by ERIM
- Labeling Procedure Delivery by UCB
- Software Development on LARS Computer Pending Availability of ERSYS at JSC
- Existing Technology Modified and Implemented
  - Procedure M tuned for Corn/Soybeans
  - LEC Labeling Procedure adapted to field-like targets rather than dots

BLOCK DIAGRAM FOR PROCEDURE M AS A GENERIC STRATIFIED AREA ESTIMATION APPROACH

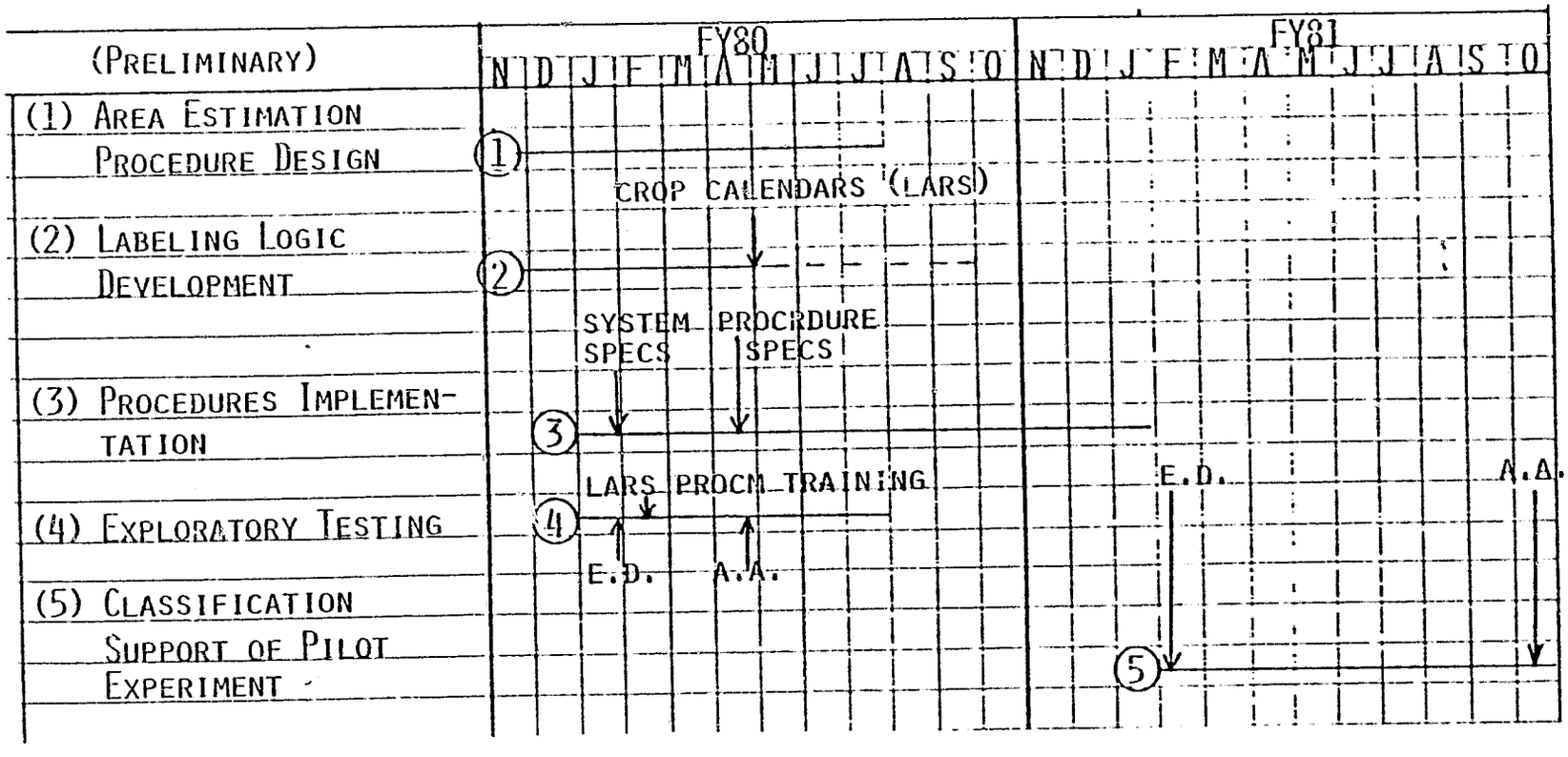


PROCEDURE M

A CORN AND SOYBEAN CONFIGURATION



FCPF TASKS AND MAJOR EXTERNAL INTERFACES FOR U.S. C/S PILOT

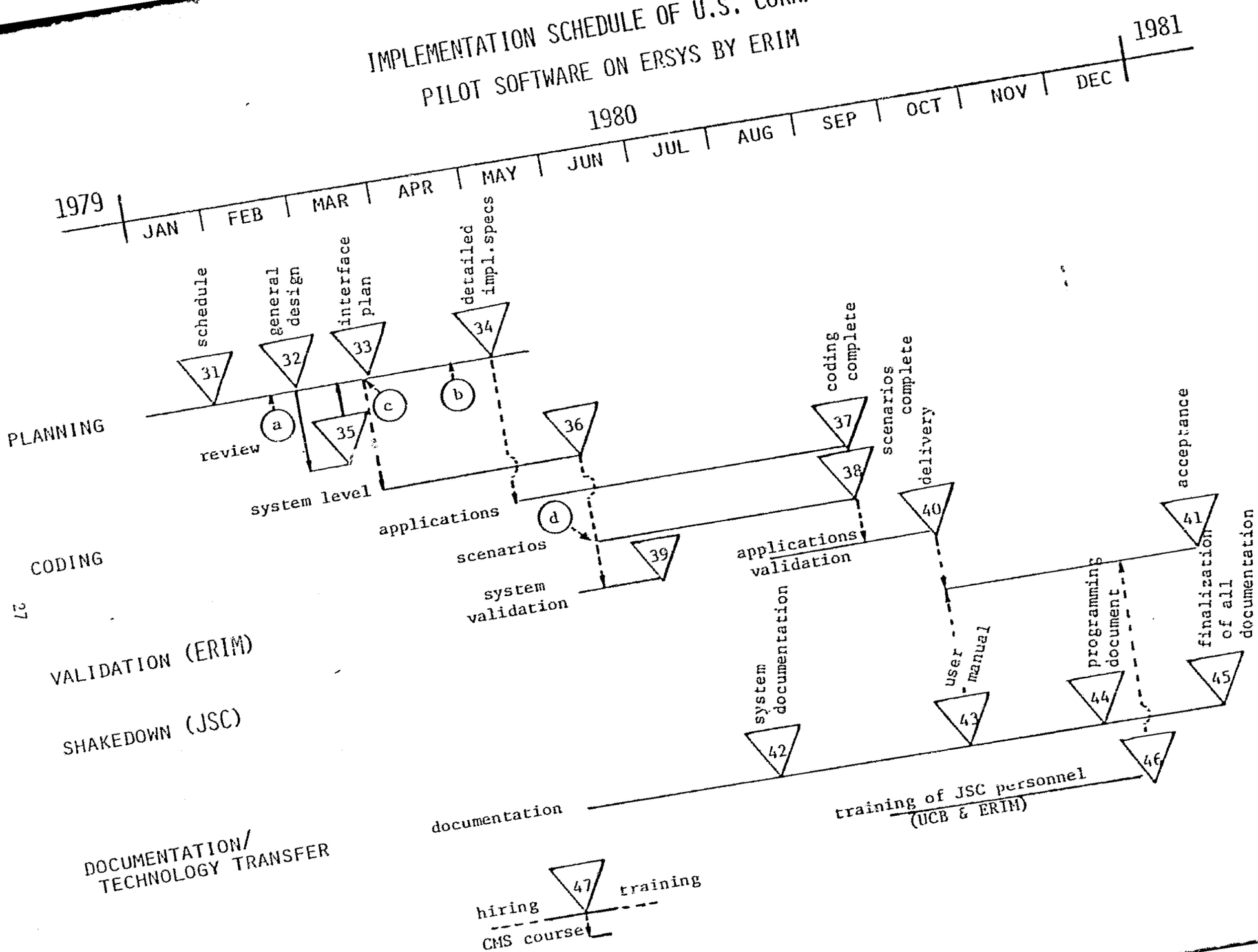


E.D. EXPERIMENT DESIGN

A.A. ACCURACY ASSESSMENT

ORIGINAL PAGE IS OF POOR QUALITY

IMPLEMENTATION SCHEDULE OF U.S. CORN/SOY PILOT SOFTWARE ON ERSYS BY ERIM



ACCOMPLISHMENTS

(15 NOVEMBER 79 - 14 FEBRUARY 80)

- IMPLEMENTATION APPROACH APPROVED BY NASA LEVEL 2 MANAGEMENT
- TECHNICAL SUPPORT PROVIDED TO ERSYS DESIGN TEAM
- DETAILED IMPLEMENTATION SCHEDULE/INTERFACE REQUIREMENTS ESTABLISHED
- ERIM DATA LINK TO JSC AND LARS DESIGNED
- PCR AND CHANGE PROPOSAL FOR DATA LINK SUBMITTED FOR APPROVAL

FUTURE PLANS

- Successful Initiation of Pilot Dependent Upon:
  - Implementation of software by 1 Oct 80 and Training provided to JSC by 1 Jan 81
- Procedure Design and Software Implementation Currently on Schedule

FY81 U.S. C/S PILOT IMPLEMENTATION

Technical Concerns

Uncertain ERSYS development schedule raises questions as to whether pilot software can be delivered into ERSYS environment at JSC on schedule.

Options

- Run Pilot on LARS
- Deliver Pilot into JSC Machine But Not into ERSYS Environment

ERIM/UCB PARTICIPATION IN

SR/FCPF DATA SYSTEMS IMPLEMENTATION

14 FEBRUARY 1980 SR SEMIANNUAL PROJECT REVIEW

ERIM/UCB DATA SYSTEMS IMPLEMENTATION

OVERALL OBJECTIVE

To support the development and application of ERSYS as a practical and useful system supporting the SR and FCPF Projects through:

- technical design advice
- implementation of procedures
- use of system
- access to data

FY80 OBJECTIVE

Implement, document and validate at JSC an Area Estimation (Classification) Procedure for the FY81 U.S. C/S Pilot

FY81 U.S. C/S PILOT IMPLEMENTATION APPROACH

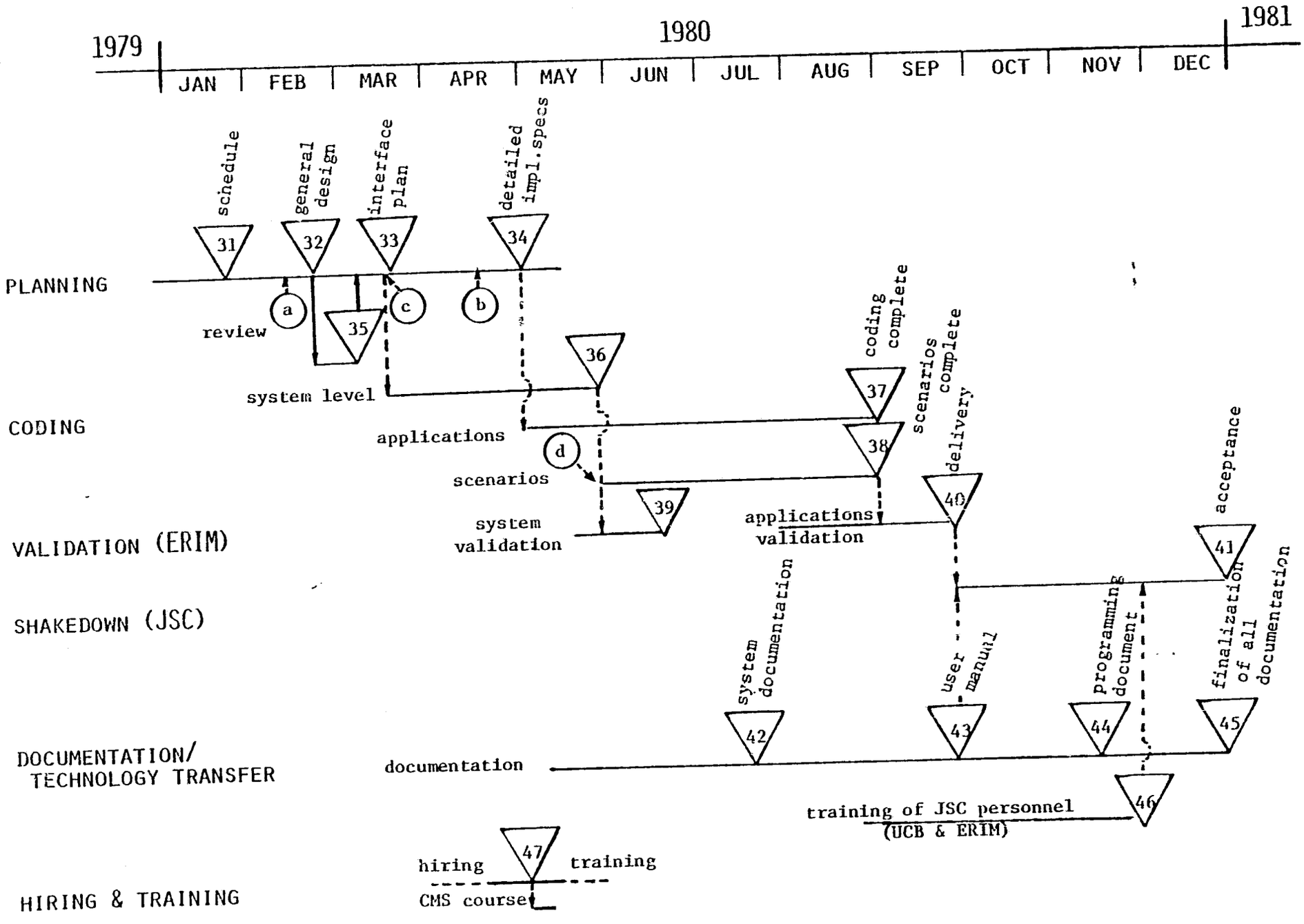
- Overall Implementation Managed by ERIM
- Labeling Procedure Delivery by UCB
- Software Development on LARS Computer Pending Availability of ERSYS at JSC
- Existing Technology Modified and Implemented
  - Procedure M tuned for Corn/Soybeans
  - LEC Labeling Procedure adapted to field-like targets rather than dots

ACCOMPLISHMENTS

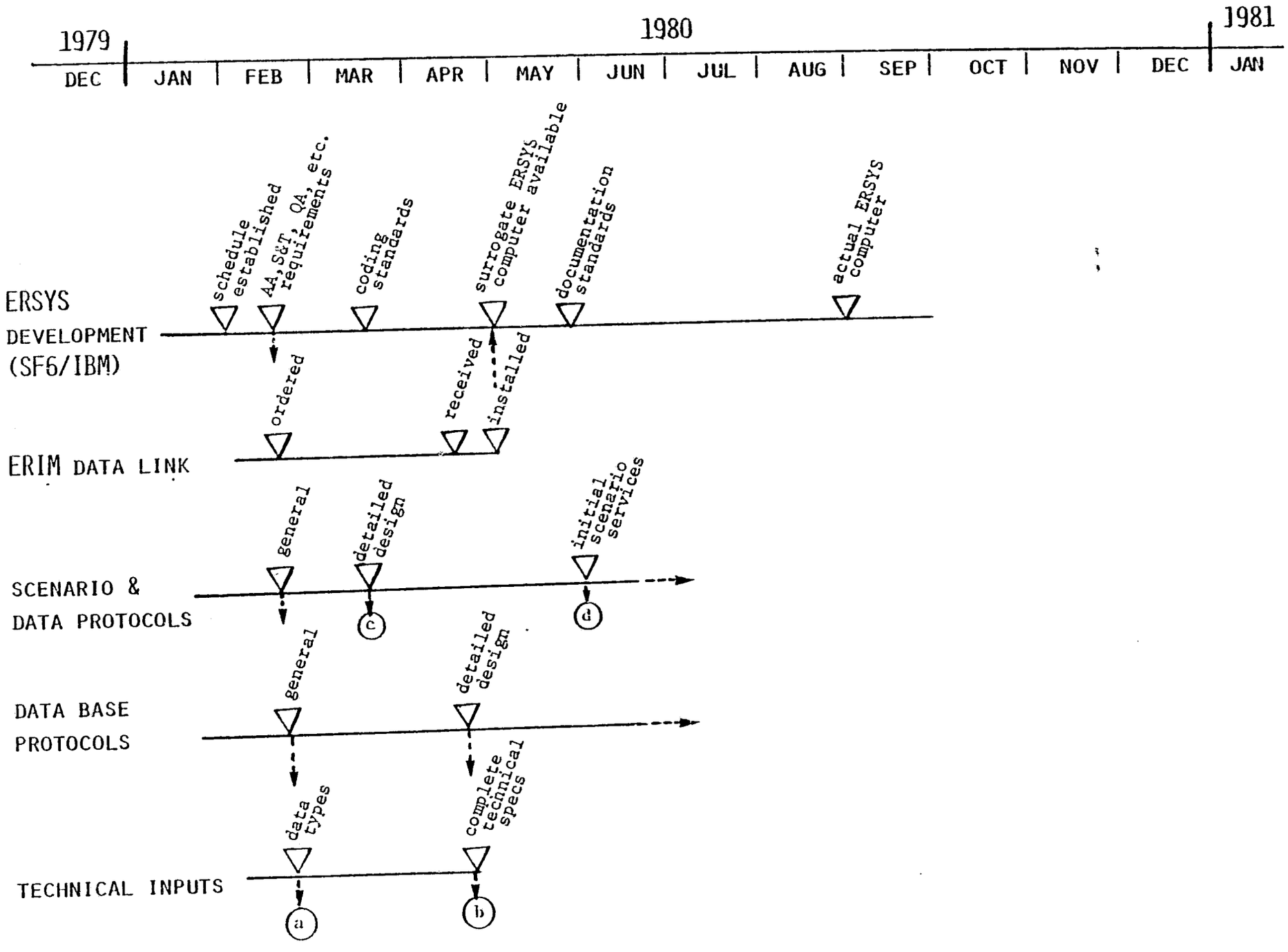
(15 November 79 - 14 February 80)

- Implementation Approach Approved by NASA Level 2 Management
- Major contribution to Alternate ERSYS Design
- Detailed Implementation Schedule/Interface Requirements Established
- ERIM Data Link to JSC and LARS Designed
- PCR and Change Proposal for Data Link Submitted for Approval

IMPLEMENTATION SCHEDULE OF U.S. CORN/SOY PILOT SOFTWARE ON ERSYS BY ERIM



INTERFACE SCHEDULE OF U.S. CORN/SOY PILOT SOFTWARE ON ERSYS BY ERIM



FY81 U.S. C/S PILOT IMPLEMENTATION

Technical Concerns

Uncertain ERSYS development schedule raises questions as to whether pilot software can be delivered into ERSYS environment at JSC on schedule.

Options

- Run Pilot on LARS
- Deliver Pilot into JSC Machine But Not into ERSYS Environment

OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT

FOR

SUPPORTING RESEARCH PROJECT

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN

14 FEBRUARY 1980 SR SEMIANNUAL PROJECT REVIEW

OBJECTIVES

- To Advance the State-of-the-Art in Labeling Technology
- To Develop Candidate Labeling Procedures for Test and Evaluation in Exploratory Experiments and Pilot Experiments Within the SR and FCPF Projects
- These Procedures Should Be:
  - Objective
  - Representative of the then-current state-of-the-art

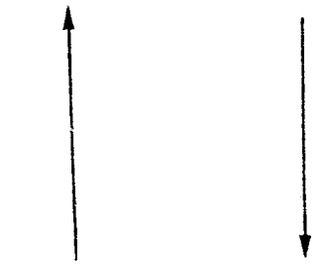
OVERALL APPROACH

- BASIC PHILOSOPHY:
  - R&D AND PROCEDURES SHOULD BE BASED ON AN UNDERSTANDING OF THE AGRONOMIC AND PHYSICAL CHARACTERISTICS OF CROPS, TOGETHER WITH UNDERSTANDINGS OF SENSOR CHARACTERISTICS, ENVIRONMENTAL CONDITIONS, AND INTERACTIONS
  - A "SIGNATURE" IS A CONDITIONAL COLLECTION OF INFORMATION ELEMENTS
  - EXTENSION TO FOREIGN SITUATIONS TO BE FACILITATED BY DETERMINING HOW AGROPHYSICAL VARIABLES DIFFER FROM THOSE IN U.S. STUDY AREAS AND PREDICTING DIFFERENCES FOR CONDITIONAL COLLECTION OF INFORMATION ELEMENTS

- DELIVERY APPROACH
  - SHOULD MEET SELECTED EXPLORATORY EXPERIMENT SCHEDULES
  - PROCEDURES MUST BE ADAPTABLE TO FOREIGN APPLICATIONS
  - FOREIGN ADAPTATION AND IMPLEMENTATION PERFORMED BY RECEIVING AREA-ESTIMATION ORGANIZATION

AGROPHYSICAL/REMOTE SENSING SIGNATURE CONCEPT

(OBJECTIVE LABELING BASED ON PHYSICAL UNDERSTANDING)



- AGROPHYSICAL SIGNATURE — DESCRIBES THE CROP AND ITS CONTEXT IN TERMS OF AGRONOMIC AND PHYSICAL PROPERTIES AND CHARACTERISTICS
- FEATURES — SPECIFIC REMOTE SENSING MANIFESTATIONS OF SPECIFIC PROPERTIES OR CHARACTERISTICS OF THE SCENE
- REMOTE SENSING SIGNATURE — THAT COLLECTION OF FEATURES WHICH TRANSLATES INTO THE AGROPHYSICAL SIGNATURE

TECHNICAL THRUSTS OF LABELING TECHNOLOGY DEVELOPMENT

- FY81
  - Wheat
  - Machine-Oriented
  - End of Season
  - Binary Labels
- FY82
  - Corn/Soybeans and Wheat/Barley
  - Machine-Analyst Integration
  - Mid-Season Technology
- FY83
  - Multicrop
  - Thematic Mapper
  - Probability Labels
  - Condition Assessment Function
- FY84
  - New Crops (Co,So,Su)

ERIM OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT

SUBTASKS

		Fiscal Years
1.	Agrophysical/Remote-Sensing Signature Development	80-84
2.	Modeling, Simulation, and Analysis Tools	80-84
3.	Research and Development of Candidate Techniques	80-84
4.	Preparation and Maintenance of an Analysis Data Base	80-84
	Develop and Implement an Objective:	
5.	Machine-Oriented Labeler for Wheat	80-81
6.	Integrated Machine/Analyst Labeler for Wheat	80-82
7.	Integrated Machine/Analyst Labeler for Corn/Soybeans	80-82
8.	Multicrop MSS/TM Labeler for Wheat/Barley	81-83
9.	Multicrop MSS/TM Labeler for Corn/Soybeans	81-83
10.	Multicrop MSS/TM Labeler for Cotton/Sorghum/Sunflowers	82-84

DELIVERY DETAILS

Subtask		Date (Quarter/FY)
5.	Machine-Oriented Labeler for Wheat	2/81
6.	Integrated Machine/Analyst-Labeler for Wheat	1/82
7.	Integrated Machine/Analyst-Labeler for Corn/Soybeans	1/82
8.	Multicrop MSS/TM Labeler for Wheat/Barley	3/83
9.	Multicrop MSS/TM Labeler for Corn/Soybeans	3/83
10.	Multicrop MSS/TM Labeler for Cotton/Soybeans/Sunflowers	3/84

ACTIVITIES AND ACCOMPLISHMENTS

(15 Nov 79 - 14 Feb 80)

- Exploratory Experiment Evaluating Two Configurations of Procedure M
  - Spring small grains configurations
  - Direct wheat configuration (Machine Labeler)
- Implementation Planning
  - Subtasks defined
  - Overall delivery schedule defined
  - Data requirements communicated to Data Acquisition Project Element

NEAR-TERM PLANS

(15 FEB 80 - 14 AUG 80)

- COMPLETE IMPLEMENTATION PLAN (MARCH 80)
- INITIATE MACHINE-ORIENTED LABELER DEVELOPMENT (FEB 80)
- INITIATE INTEGRATED MACHINE/ANALYST LABELER DEVELOPMENT (AUG 80)
- INITIATE ALL GENERIC TECHNOLOGY SUBTASKS (FEB 80)

ISSUES

- AGROPHYSICAL SUPPORT (BEING WORKED INFORMALLY THIS YEAR / INTERNALLY STAFFED NEXT YEAR)

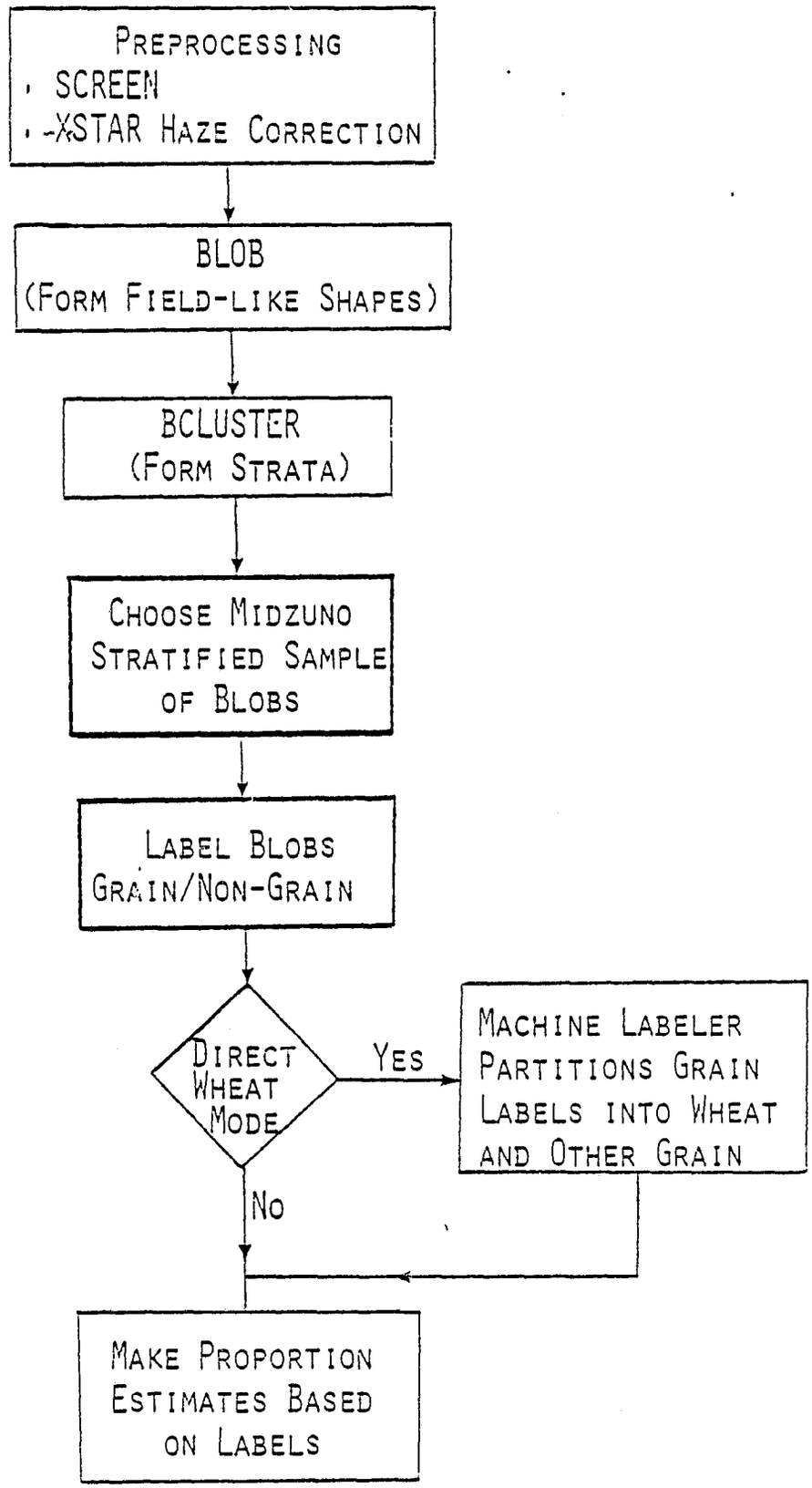
EVALUATION OF THE
DIRECT WHEAT ESTIMATION CONFIGURATION
OF PROCEDURE M

AN SR EXPLORATORY EXPERIMENT FOR FCPF

EXPLORATORY EXPERIMENT - OBJECTIVES

- Evaluate Direct Wheat Estimation Configuration of Procedure M Using AI Labels
- Evaluate a Machine Labeling Procedure for Separation of Spring Small Grains into Spring Wheat/Other Spring Small Grains
- Evaluate an Embryonic System Error Model

PROCEDURE M CONFIGURATIONS TESTED



DESCRIPTION OF MACHINE LABELING TECHNIQUE

BASIC STEPS

- Receive Sample Labeled "Small Grain" by AI.
- Adjust Acquisition History for Spectrally-Indicated Variations in Stage of Development on Actual Days of Observation.
- Adjust Algorithm Based on Spectral Indicators of Segment Moisture Stress and Soil Brightness.
- Compute a Physically-Based Spectral Discrimination Feature and Assign Label "Wheat" or "Other Small Grain" Accordingly.

EXPLORATORY EXPERIMENT - APPROACH

- 13 NORTHERN GREAT PLAINS TY 78 BLIND SITES
  HAVING EXHAUSTIVE GRAIN/NON-GRAIN AI LABELS

- 50 ITERATIONS OF TOTAL PROCEDURE FOR EACH SEGMENT
  - -- AI LABELS
  - -- GT LABELS

- SUBSTITUTION OF GROUND-TRUTH-TUNED OPTIMAL LINEAR
  DISCRIMINANT FOR MACHINE LABELER

EXPLORATORY EXPERIMENT-RESULTS

- SPRING SMALL GRAIN ESTIMATES
  - AI LABELING ERRORS PASS DIRECTLY THROUGH THE SYSTEM AND CONSTITUTE THE DOMINANT SOURCE OF ERROR
  - BIAS IN PROPORTION ESTIMATE = -5.7% (-15.7% REL)
  - SEGMENT EFFECTS ARE SUBSTANTIAL
- DIRECT WHEAT ESTIMATES
  - INTERACTION BETWEEN AI ERRORS AND MACHINE LABELER ERRORS PASS DIRECTLY THROUGH THE SYSTEM AND CONSTITUTE THE DOMINANT SOURCE OF ERROR (40% OF ERROR ASSOCIATED WITH MACHINE, 60% WITH AI)
  - BIAS IN PROPORTION ESTIMATE = -11.7% (-50.4% REL)
  - SEGMENT EFFECTS AND SAMPLING EFFECTS ARE SUBSTANTIAL

RESULTS (CONTINUED)

- MACHINE LABELER
  - MORE ACCURATE DISCRIMINATION AMONG SPRING SMALL GRAINS MAY BE POSSIBLE, BUT THIS MAY NOT SUBSTANTIALLY IMPROVE DIRECT WHEAT ESTIMATES
- THE PROCEDURE M ERROR MODEL APPEARS TO BE A USEFUL FIRST STEP IN DEVELOPMENT OF A SYSTEM ERROR ASSESSMENT COMPONENT

SIGNIFICANCE OF RESULTS

- THIS EXPERIMENT SUPPORTS PREVIOUS EXPERIMENTS INDICATING THAT LABELING IS THE PRIMARY SOURCE OF ERROR IN CURRENT AREA ESTIMATION TECHNOLOGY. NEW METHODS TO REDUCE THAT ERROR, OR PROCEDURES TO MINIMIZE ITS NET IMPACT ARE NECESSARY.

- THIS EXPERIMENT INDICATES THAT LANDSAT MSS DATA ALONE MAY NOT CONTAIN SUFFICIENT INFORMATION TO SUPPORT ACCURATE DIRECT WHEAT ESTIMATES IN THE PRESENCE OF OTHER SMALL GRAINS. OTHER APPROACHES (E.G., DIRECT PROPORTION ESTIMATORS) AND/OR NEW INFORMATION SOURCES (E.G., THEMATIC MAPPER) ARE NECESSARY.

- THIS EXPERIMENT DEMONSTRATES THAT PROCEDURE M HAS PROPERTIES SIMILAR TO PROCEDURE 1, AND THAT IT REPRESENTS A VIABLE ALTERNATIVE AS A SEGMENT PROPORTION ESTIMATION PROCEDURE.

BASELINE PROCEDURE FOR

CORN AND SOYBEAN CLASSIFICATION FOR AREA ESTIMATION

COMBINED TECHNICAL EFFORT OF

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN

AND

UNIVERSITY OF CALIFORNIA AT BERKELEY

5 MARCH 1980

PURPOSE OF PRESENTATION

- To provide information regarding the current status of the development of a baseline procedure for segment classification processing in the U.S. corn and soybean pilot experiment

- To present the current configuration of the procedure and our plans for further development and implementation

- Note that though the procedure is configured, specific details are in the process of being defined

OUTLINE OF PRESENTATION

- o Objectives
- o Approach
- o Baseline Procedure
  - Scope
  - Technical Concept
  - Major Elements
  - Procedure Flow
  - Analyst Interfaces
- o Implementation
  - Design
  - Analyst Procedure Development
  - Component Test and Evaluation
  - Computer Implementation
  - Required Technical Interfaces
  - Schedule
- o Summary

OBJECTIVE

- DEVELOP AND IMPLEMENT A BASELINE CORN AND SOYBEAN AREA ESTIMATION PROCEDURE FOR THE FY 81 U.S. PILOT EXPERIMENT BASED ON CURRENTLY AVAILABLE TECHNOLOGY UTILIZING STANDARD SAMPLE SEGMENTS AND ANALYST LABELS

Technical Approach

- Procedure M will provide the basic machine processing environment
- Analyst labeling procedures that are compatible with machine processing components will be developed from existing corn and soybean labeling guidelines and procedures
- Limited exploratory test and evaluation will be conducted at JSC and ERIM to qualify and tune procedure components
- A data systems group will be designated at ERIM to implement the procedure in the appropriate (ERSYS) processing environment

APPROACH

TECHNICAL ADMINISTRATION

- UCB AND ERIM WORK AS A TEAM TO DESIGN AND IMPLEMENT THE BASELINE PROCEDURE
- UCB ASSUMES PRIMARY RESPONSIBILITY FOR THE TECHNICAL DEVELOPMENT, DOCUMENTATION AND TRAINING FOR ANALYST PROCEDURES
- ERIM ASSUMES PRIMARY RESPONSIBILITY FOR THE TECHNICAL DEVELOPMENT DOCUMENTATION AND TRAINING FOR MACHINE PROCESSING COMPONENTS OF THE PROCEDURE
- ERIM ASSUMES PRIMARY RESPONSIBILITY FOR THE IMPLEMENTATION OF THE PROCEDURE IN AN ACCEPTABLE ENVIRONMENT FOR PILOT PROCESSING
- ERIM ASSUMES THE OVERALL MANAGEMENT RESPONSIBILITY

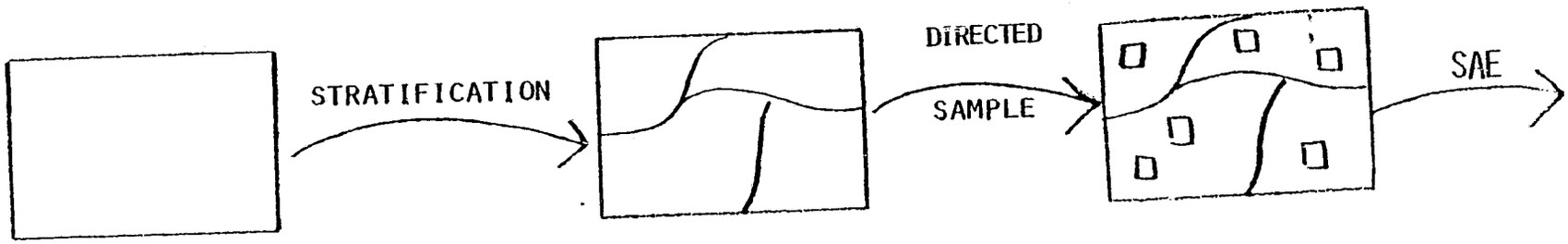
BASELINE PROCEDURE

SCOPE

- o INTEGRATE (STATE-OF-THE-ART) TECHNOLOGY BORNE OUT OF LACIE AND LACIE TRANSITION INTO AN END-TO-END CORN AND SOYBEAN SEGMENT CLASSIFICATION PROCEDURE FOR AREA ESTIMATON
  - ANALYST LABELING TECHNOLOGY
  - MACHINE PROCESSING TECHNOLOGY
- o DESIGN THE PROCEDURE IN A MANNER THAT MAKES THE INFLUENCE OF EACH OF ITS COMPONENT PARTS TRACKABLE
- o THE PROCEDURE SHOULD BE A BASELINE FROM WHICH TO DEVELOP IMPROVED COMPONENT TECHNOLOGIES AND TO JUDGE THE INCREMENTAL AFFECT OF THOSE IMPROVEMENTS
- o THE END GOAL IS TO EVALUATE THE POTENTIAL OF THE PROCEDURE AND ITS COMPONENTS IN TERMS OF ACCURACY AND EFFICIENCY, NOT TO DESIGN THE PROCEDURE TO A PRE-SPECIFIED CRITERION

Baseline Procedure Concept

- Stratified Area Estimates are produced

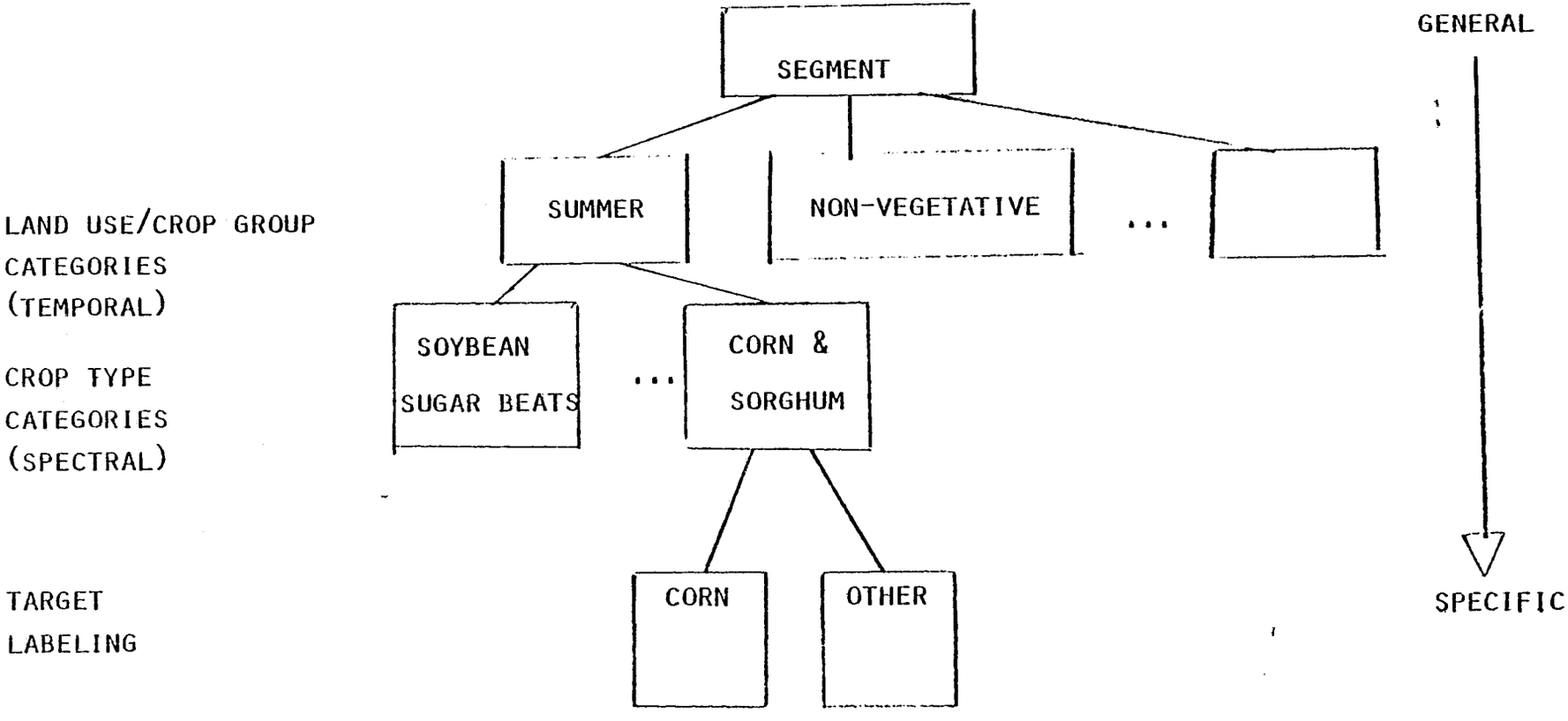


- This is the same concept proposed by P1A, it differs from P1 in that stratification does not require training samples

- A gain in efficiency will be realized
  - Samples are not used for stratification
  - Multiple strata produced have resulted in improved R factors

Baseline Procedure Concept

- Procedure processing is hierarchical in nature



Major Baseline Procedure Elements

- **Normalization:** Physical structure and attributes of sensors, acquisition geometry, atmosphere and scene are normalized to standardize interpretability of features
- **Stratification:** Temporal, spectral and spatial stratification is conducted to facilitate the sampling and measurement process
- **Measurement:** Both analyst and machine techniques will be utilized to label features of interest
- **Estimation:** Segment level estimates will be produced at the level warranted by the available data

Major Baseline Procedure Elements

Normalization

- Sensors
- Screening
- Sun Angle
- Haze

Stratification

- Land use/Crop group (DFS)
- Refined crop group (BCLUSTER)
- Fields (BLOB)
- Field Size

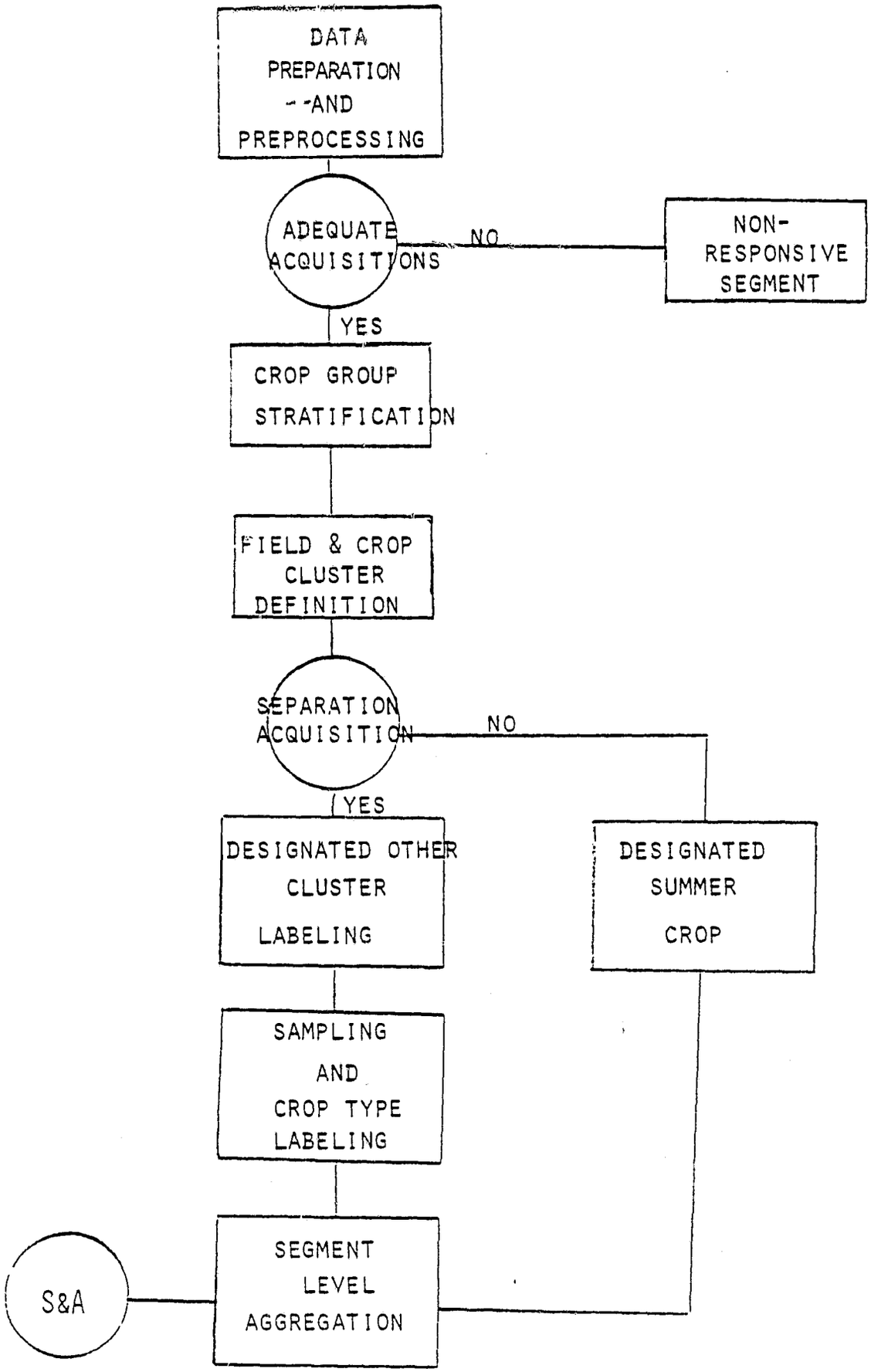
Measurement

- H^2O
- Non-vegetative
- DO
- Crop group
- Crop type

Estimation

- Non-response
- Summer crop
- Summer crop group
- Corn, soybean, other, unknown

PROCEDURE FLOW



A. DATA PREPARATION AND PREPROCESSING

1. DATA ACQUISITION
2. INITIALIZATION OF SEGMENT STATUS AND TRACKING
3. PACKET PREPARTION
4. DATA SCREENING
5. ACQUISITION QA FOR CLOUDS AND DENSE HAZE
6. NON-RESPONSE DETERMINATION
7. XSTAR
8. FEATURE EXTRACTION

B. CROP GROUP STRATIFICATION

1. TEMPORAL PATTERN CLASS (TPC) EXTRACTION

2. GENERATION OF LAND USE/CROP GROP ANALYST AIDS

3. CROP GROUP AND LAND USE STRATIFICATION (BASED ON TEMPORAL PATTERNS)

    - o SUMMER CROPS
    - o SMALL GRAINS
    - o NON-VEGETATION
    - o PASTURE, RAGELAND, FOREST
    - o UN/SSIGNABLE
    - o TRIVIAL TEMPORAL PATTERNS

C. FIELD AND CROP CLUSTER DEFINITIONS

1. SELECTION OF ACQUISITIONS FOR FIELD DEFINITION
2. FIELD DEFINITION
3. FIELD SIZE STRATIFICATION
4. SPECTRAL STRATIFICATION (BCLUSTER)
5. DETERMINATION OF AVAILABILITY OF SEPARATION ACQUISITION

D. DESIGNATED OTHER CLUSTER LABELING

1. GENERATION OF CLUSTER SPECTRAL AIDS

   - o PFC COLOR CODED STRATA MAP
   - o CLUSTER TRAJECTORY PLOTS

2. DESIGNATION OF CLUSTERS AS 'OTHER' IF SEPARATION ACQUISITION IS AVAILABLE

3. DESIGNATION OF CLUSTERS AS 'SUMMER CROP' IF SEPARATION ACQUISITION IS NOT AVAILABLE

E. SAMPLING AND CROP TYPE LABELING

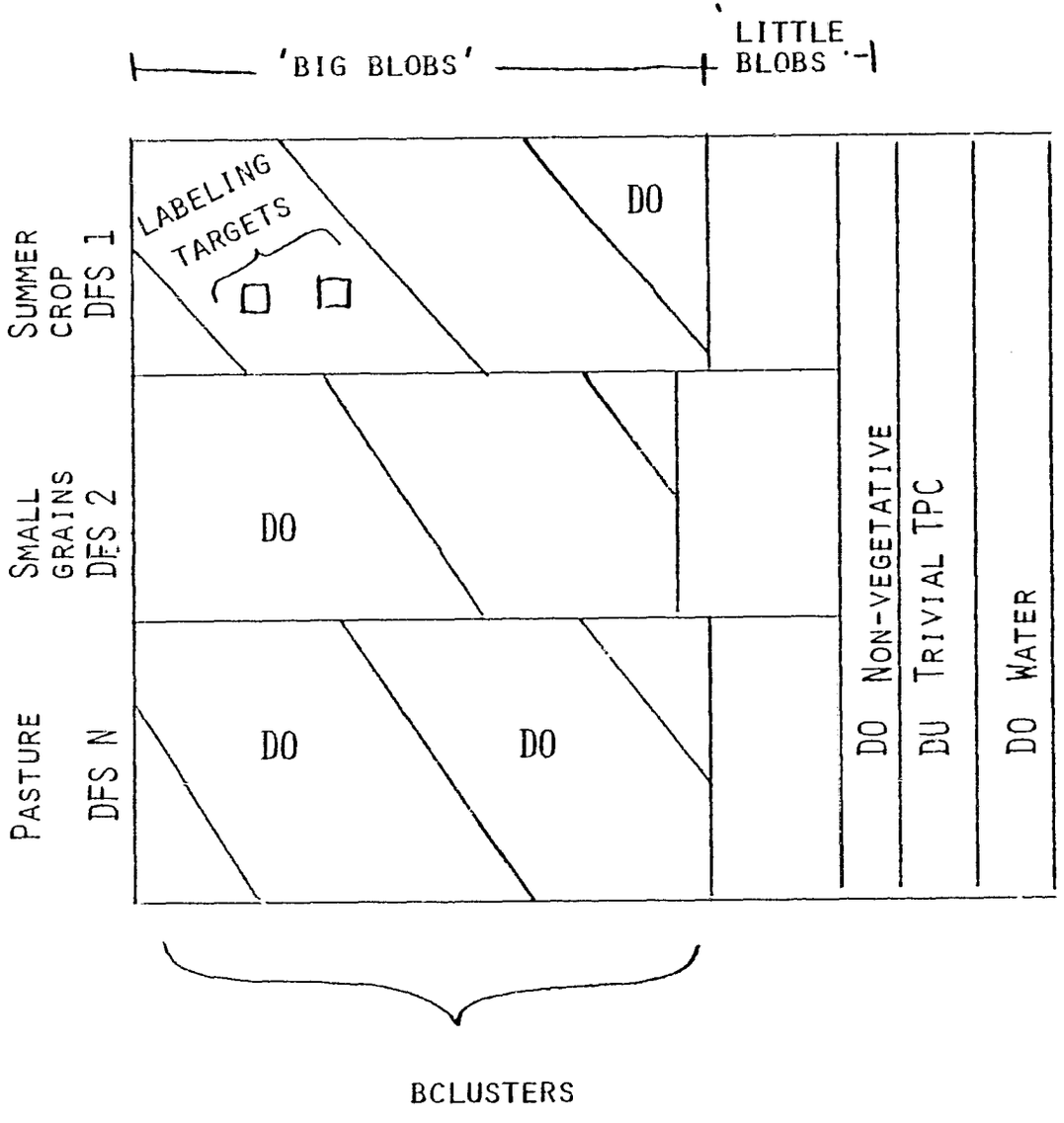
1. SAMPLE SELECTION USING MIDZUNO TECHNIQUE

2. GENERATION OF SPECTRAL AIDS

   - o PFC OVERLAY AND ENCODING FORM
   - o QUASI-FIELD AIDS

3. ANALYST CROP TYPE LABELING OF SAMPLED QUASI-FIELDS

F. ESTIMATION



ANALYST INTERFACES

GENERAL GUIDELINES FOR DEVELOPING AND DESIGNING PROCEDURES

- TO DRAW ON CURRENT MANUAL ANALYSIS TECHNOLOGY
  - LEMSCO CORN/SOYBEAN PROCEDURE
  - UCB CORN/SOYBEAN LABELING GUIDELINES
  - UCB DELTA FUNCTION STRATIFICATION PROCEDURE
  - PROCEDURE M - QUASI-FIELD LABELING TARGETS
- TO ANALYZE DATA FROM GENERAL TO SPECIFIC
- TO MAKE MANUAL ANALYSIS PROCEDURES AS OBJECTIVE AS POSSIBLE
- TO INTEGRATE ANALYST AND MACHINE PROCESSING COMPONENTS EFFICIENTLY

ANALYST INTERFACES

AREAS OF MAJOR ANALYST INVOLVEMENT

- PROCEDURE FLOW
  - ACQUISITION SELECTION
  - SEGMENT NON-RESPONSE DETERMINATION
  - SEGMENT ANALYSIS TRACKING

- LAND USE/MAJOR CROP GROUP STRATIFICATION
  - TEMPORAL STRATIFICATION

- CROP TYPE MEASUREMENTS
  - B-CLUSTER DO'ING (SPECTRAL STRATIFICATION)
  - LABELING OF QUASI-FIELDS

ANALYST INTERFACES

PROCEDURE FLOW

- PURPOSE OF COMPONENT
  - TO DETERMINE IF ACQUISITIONS ARE SUFFICIENT FOR SEGMENT PROCESSING (NON-RESPONSE DETERMINATION)
  - TO SELECT ACQUISITIONS FOR MACHINE PROCESSING
  - TO DOCUMENT AI DECISIONS AT CRITICAL STEPS FOR ANALYSIS BY ACCURACY ASSESSMENT
- BASIC PROCEDURES
  - NON-RESPONSE DETERMINATION/SPECIFICATION OF ACQUISITIONS FOR TEMPORAL PATTERN CLASS EXTRACTION
    1. ACQUISITION SCREENING FOR CLOUDS AND HAZE
    2. ANALYST ADJUSTMENT OF CROP CALENDAR TO SEGMENT
    3. DETERMINATION OF ACQUISITION SUFFICIENCY FOR SEGMENT PROCESSING
    4. SPECIFICATION OF ACQUISITIONS TO ENSURE MAXIMUM SEPARATION AMONG LAND USE/CROP GROUPS
  - ACQUISITIONS SELECTION FOR QUASI-FIELD DEFINITION
    1. STRATIFIED SCATTER PLOTS GENERATED FOLLOWING CROP GROUP STRATIFICATION
    2. SPECIFICATION OF ACQUISITIONS TO ENSURE MAXIMUM SEPARATION BETWEEN CORN AND SOYBEANS
- COMPONENT OUTPUT
  - ACQUISITION SELECTIONS OR SEGMENT DROPOUT
  - SEGMENT ANALYSIS HISTORY

ANALYST INTERFACES

LAND USE/MAJOR CROP GROUP STRATIFICATION

- PURPOSE OF COMPONENT
  - TO PARTITION SEGMENT INTO RELEVANT LAND USE STRATA TO MAXIMIZE THE EFFICIENCY OF LABELING TARGET SAMPLE ALLOCATION
  - TO HELP MAINTAIN QUASI-FIELD PURITY
  - TO AID IN GENERATION OF ANALYST SPECTRAL AIDS
  - TO OBJECTIFY SEPARATION OF MAJOR LAND USE CLASSES AND CROP GROUP CLASSES

- BASIC PROCEDURE

1. ANALYST ADJUSTMENT OF CROP CALENDARS TO SEGMENT
2. ANALYST SELECTION OF ACQUISITIONS FOR PROCESSING
3. AUTOMATIC EXTRACTION OF TEMPORAL PATTERN CLASSES (TPC)
   - LINEAR DISCRIMINANT USED WITH GREEN VEGETATION INDICATOR
4. ANALYST TEAM ASSIGNMENT OF TPC'S TO LAND USE/CROP GROUP STRATA

ANALYST INTERFACES (CONTINUED)
LAND USE/MAJOR CROP GROUP STRATIFICATION

- COMPONENT OUTPUT
  - LAND USE/CROP GROUP STRATA FOR WITHIN SEGMENT SAMPLE ALLOCATION
    - SMALL GRAINS
    - SUMMER CROPS
    - NON-VEGETATED
    - PASTURE, RANGE
    - UNASSIGNABLE TPC'S (> 50 PIXELS)
    - TRIVIAL TPC'S (< 50 PIXELS)
  - CONTROL-MASK FOR QUASI-FIELD EXTRACTION
  - STRATA MASK FOR PRODUCTION OF STRATIFIED ANALYST SPECTRAL AIDS

ANALYST INTERFACES

DESIGNATED OTHER (DO) BCLUSTER LABELING

- PURPOSE OF COMPONENT
  - TO IDENTIFY DEFINITE NON-SUMMER CROP CLUSTERS FOR EXCLUSION FROM SAMPLE ALLOCATION
  - TO PERFORM QUALITY CONTROL CHECK ON ANALYST TEAM CROP GROUP STRATIFICATION
- BASIC PROCEDURE

1. AUTOMATIC DO'ING OF WATER THROUGH SCREEN
2. AUTOMATIC DO'ING OF NON-VEGETATED CLASSES FOLLOWING TEMPORAL PATTERN CLASS EXTRACTION
3. QUASI-FIELD DEFINITION, SPECTRAL STRATIFICATION WITHIN CROP GROUP STRATA
4. SPECTRAL AIDS FOR B-CLUSTERS GENERATED
   - TEMPORAL PLOTS
   - TRAJECTORY PLOTS
5. AI ASSESSES ACCURACY OF CROP GROUP STRATIFICATION USING ADDITIONAL SPECTRAL INFORMATION
6. AI IDENTIFIES DEFINITE NON-SUMMER CROP CLUSTERS

- COMPONENT OUTPUT
  - SPECIFICATION OF DO'D CLUSTERS
  - VERIFICATION OF CROP GROUP STRATIFICATION

ANALYST INTERFACES

LABELING OF QUASI-FIELDS

- PURPOSE OF COMPONENT
  - TO ASSIGN CROP TYPE LABELS (CORN, SOYBEAN, OTHER) TO QUASI-FIELD SAMPLE FOR PRODUCTION OF SEGMENT ESTIMATE
- BASIC PROCEDURE
  1. SELECTION OF SEPARATION ACQUISITION(S)
  2. VERIFICATION THAT QUASI-FIELD WAS ASSIGNED TO PROPER LAND USE/ MAJOR CROP GROUP STRATA
  3. APPLICATION OF DECISION BOUNDARIES TO SCATTERPLOTS AND AI LABELING OF QUASI-FIELDS AS TO CORN OR SOYBEANS OR OTHER
- COMPONENT OUTPUT
  - CORN/SOYBEAN/OTHER LABELS FOR QUASI-FIELDS

ANALYST INTERFACES

BASELINE ANALYST PROCEDURES INCORPORATE MANY ELEMENTS OF LEMSCO CORN/SOYBEANS PROCEDURE

- APPROACH TO DATA ANALYSIS FLOW
  - GENERAL TO SPECIFIC
  - CROP GROUP/LAND USE CATEGORY TO CROP TYPE
- EMPHASIS ON OBJECTIVITY
- GOAL OF EFFICIENT ANALYST/MACHINE INTEGRATION
- LEMSCO ANALYST FUNCTIONS PRESERVED IN NEW PROCEDURE
  - ACQUISISTION SELECTION
  - DO'ING
  - CROP GROUP/LAND USE CATEGORY IDENTIFICATION
  - SPECIFIC SUMMER CROP TYPE LABELING

- ANALYST TEAM CONCEPT FOR CONSISTENCY

- LANDSAT DATA PRODUCTS

  - PFC PRODUCTS 1 AND 3
  - SCATTER PLOTS
  - TEMPORAL PLOTS
  - TRAJECTORY PLOTS

ANALYST INTERFACES

INNOVATIONS IN BASELINE PROCEDURE RELATIVE TO AI

- ALTERNATIVE LABELING TARGETS: QUASI-FIELDS
  - AUTOMATIC FIELD DEFINITION
  - SPECTRALLY MIXED, TEMPORALLY MISREGISTERED PIXELS NOT DIRECTLY IDENTIFIED BY AI
  - LABELING ON REFERENCE ACQUISITION NOT NESSARY

- IMPROVED AVAILABILITY OF DATA FOR CROP IDENTIFICATION
  - PURE NUMERIC SPECTRAL DATA FROM FIELD CENTERS
  - SPECTRAL AIDS AVAILABLE FROM BEGINNING
  - STRATIFIED SCATTER PLOTS
  - INCREASED DENSITY OF SPECTRAL SAMPLE FOR SCATTER PLOTS
    - 5x5 PIXEL GRID
  - REGISTERED MULTITEMPORAL LABELING AIDS
  - SOME PROVISION FOR AI TO SPECIFY ADDITIONAL SPECTRAL AIDS WHERE NECESSARY

- EXTENSION OF ANALYST FUNCTIONS

  - CROP GROUP/ LAND USE STRATIFICATION
  - DOING OF B-CLUSTERS

IMPLEMENTATION

ANALYST PROCEDURE DEVELOPMENT

- DEFINITION OF PACKET CONFIGURATION
- SPECIFICATION OF ANALYST AIDS
- DESIGN OF SEGMENT ANALYSIS HISTORY FORM
- PROCEDURE DEFINITION
    - ACQUISITION SELECTION FOR MACHINE PROCESSING
        - TEMPORAL PATTERN CLASS EXTRACTION
        - FIELD DEFINITION
    - CALIBRATION OF CROP CALENDAR TO SEGMENT
    - CROP GROUP STRATIFICATION
    - DO'ING OF B-CLUSTERS
    - LABELING OF QUASI-FIELDS
        - USE OF SPECTRAL AIDS
        - APPLICATION OF GUIDELINES

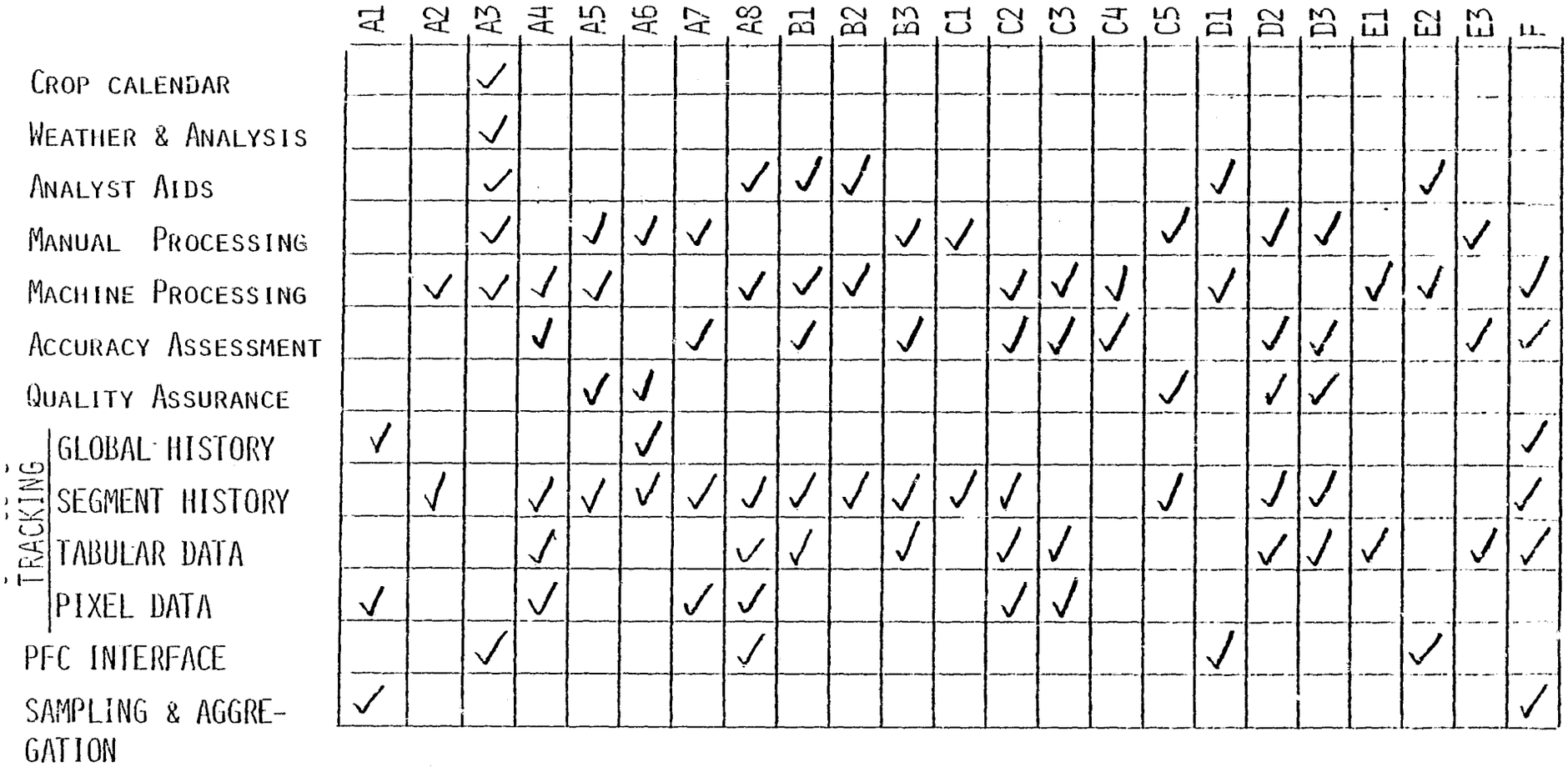
DEVELOPMENT AND EVALUATION

- FAMILIARIZATION AND QUALIFICATION TESTING AT JSC
  - USING PROCEDURE M ON LARS
  - USING CORN AND SOYBEAN LABELING GUIDELINES
- QUALIFICATION AND PROCEDURE TUNING TESTS AT ERIM
  - PREPROCESSING PROCEDURES
  - SPECTRAL AIDS FOR LABELING CLUSTERS AND BLOB TARGETS
  - DO, DU PROCEDURE EVALUATION
  - HIERARCHICAL STRATIFICATION EVALUATION

COMPUTER IMPLEMENTATION

- o SOFTWARE DESIGN
  - FORTRAN COMPATIBLE
  - MODULAR DESIGN
  - INTERACTIVE USER INTERFACE
  - SEGMENT STATUS AND TRACKING
- o SOFTWARE IMPLEMENTATION
  - CMS VIRTUAL MACHINE ENVIRONMENT
  - INITIALLY LARS IBM/3030 THEN ERSYS IBM/4341
  - COMPATIBLE TO PROVIDED ERSYS PROTOCOL
- o INTEGRATION AND VALIDATION
- o DOCUMENTATION
  - PROCEDURAL
  - PROGRAMMER AND ENGINEERING
- o TRAINING
  - ANALYST LABELING LOGIC
  - BASELINE PROCEDURES

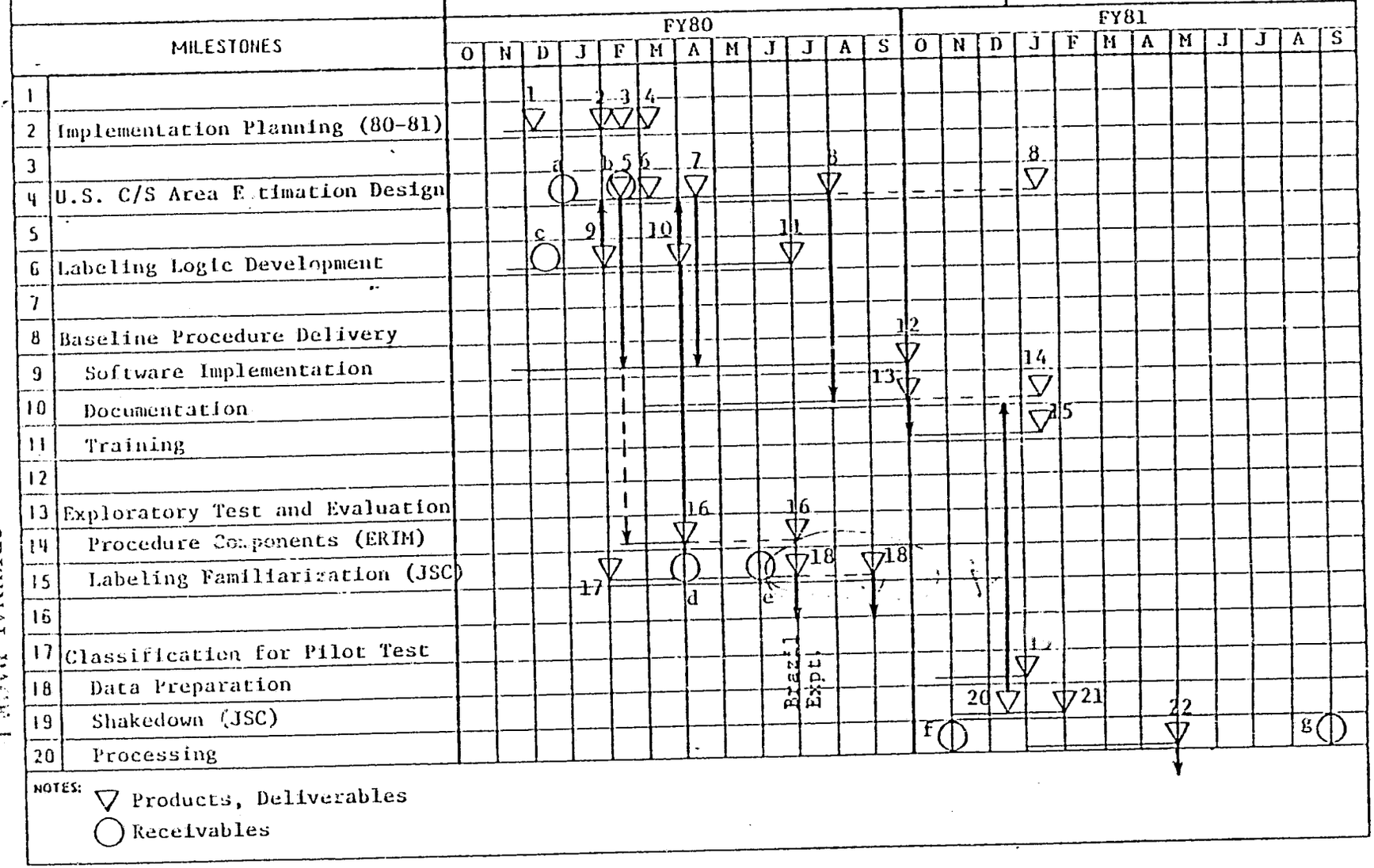
PROCESSING AND TECHNICAL INTERFACES



CORN AND SOYBEAN CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

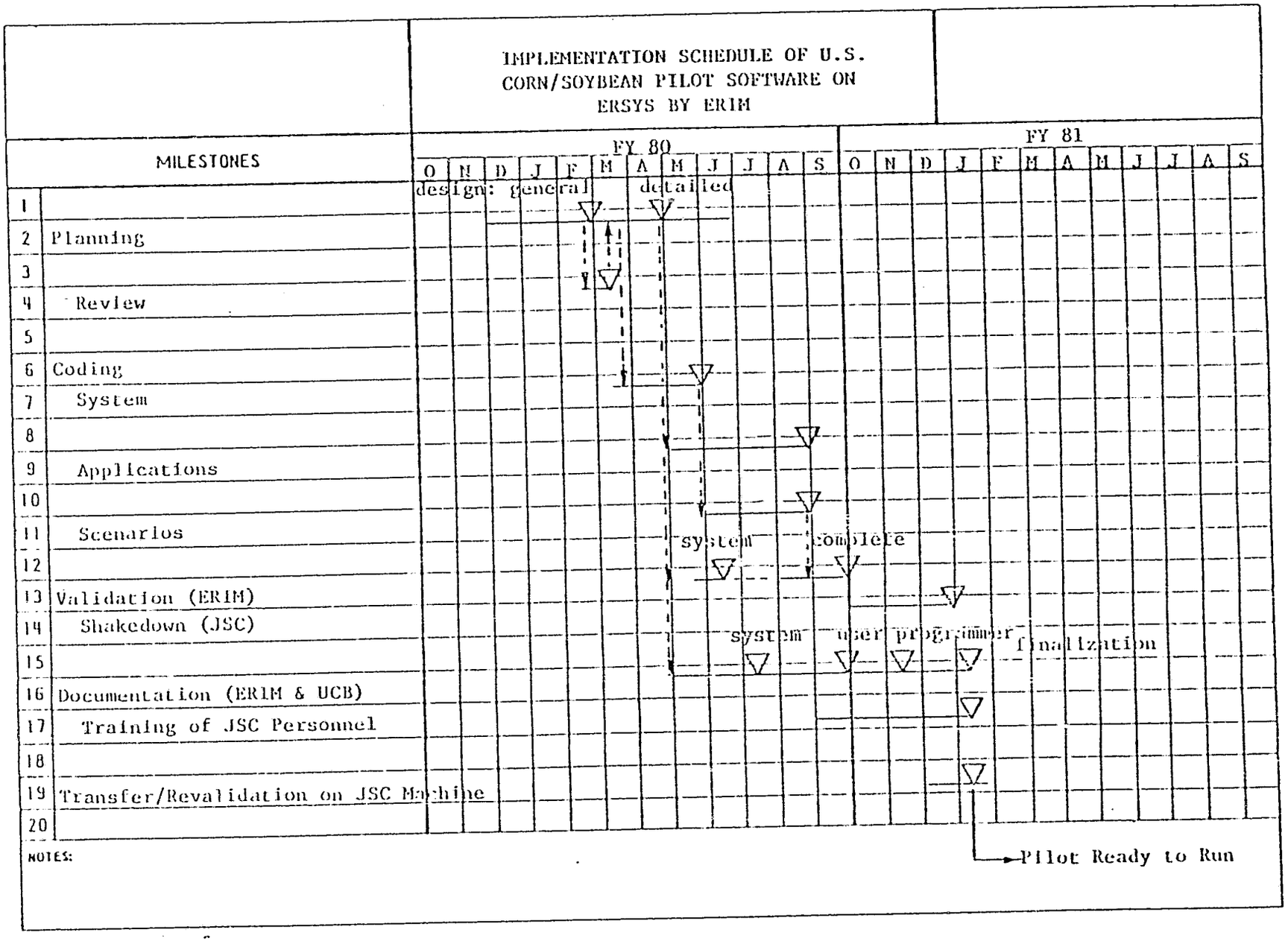
Fiscal Years 1980-1981
Integrated Schedule

Foreign Commodity Production Forecasting
U.S. Technology Phase 1



ORIGINAL PAGE IS
OF POOR QUALITY

IMPLEMENTATION SCHEDULE OF U.S. CORN/SOYBEAN PILOT SOFTWARE ON ERSYS BY ERIM



- THE PROCEDURE IS A HIERARCHICAL APPROACH THAT INTEGRATES STATE-OF-THE-ART MACHINE PROCESSING COMPONENTS WITH ANALYST PROCEDURES IN A MANNER WHEREIN THE CONTRIBUTION OF COMPONENTS IS TRACKABLE

- PRELIMINARY PROCEDURE SPECIFICATIONS HAVE BEEN DELIVERED TO AN ERIM DATA SYSTEMS GROUP FOR IMPLEMENTATION

- DEVELOPMENTAL AND EXPLORATORY TEST AND EVALUATIONS ARE PLANNED TO ASSIST IN THE FINAL DESIGN SPECIFICATION